

OXYGEN ISOTOPE COMPOSITION OF ALMAHATA SITTA. D. Rumble¹, M. E. Zolensky², J. M. Friedrich³, P. Jenniskens⁴, and M. H. Shaddad⁵, ¹Geophysical Laboratory, Carnegie Institution, Washington, DC 20015 (rumble@gl.ciw.edu), ²NASA Johnson Space Flight Center, 2101 NASA Parkway, Houston, TX 77058, ³Department of Chemistry, Fordham University, 441 East Fordham Road, Bronx, NY 10458, ⁴Carl Sagan Center, SETI Institute, 515 North Whisman Road, Mountain View, CA 94043, ⁵Department of Physics, University of Khartoum, P. O. Box 321, Khartoum 11115, Sudan.

Introduction: The name “Almahata Sitta” is applied collectively to some hundreds of stones that were found in a linear strewn field in the Nubian Desert coincident with the projected Earth-impacting orbit of the Asteroid 2008 TC₃ [1]. Fragments of the meteorite were collected in December 2008 and March 2009, 2 to 5 months after the asteroid exploded in Earth’s atmosphere on 7 October 2008.

Method: Eleven fragments of the meteorite have been analyzed for oxygen isotopes with a MAT 252 mass spectrometer using oxygen generated by heating 2-3 mg samples with a CO₂ laser in an atmosphere of BrF₅ under a pressure of 25 torr. Whole rock samples were crushed with a boron nitride mortar and pestle, ultrasonicated in dilute HCl for 5 minute, washed in de-ionized distilled water, and dried prior to analysis.

Results: Ten of the fragments span the same range of values of $\delta^{18}\text{O}$, $\delta^{17}\text{O}$, and $\Delta^{17}\text{O}$, and follow the same trend along the CCAM line as monomict and polymict members of the ureilite family of meteorites, as found in the classic work of Clayton & Mayeda [2], (Fig. 1).

There is a distinct clumping of oxygen isotope compositions for samples #4, 15, 44, and 49 so that their plotted data points are mutually obscuring (Fig. 1). These four samples, together with #47, show a limited variation in $\Delta^{17}\text{O}$, from -1.07 to -0.91 ‰. Franchi [3] observed sub-groups of ureilite analyses at discrete $\Delta^{17}\text{O}$ values, in particular at -0.98‰ (0.075‰ bin). Almahata Sitta analytical results for #4, 15, 44, 47, and 49 lie within Franchi’s sub-group. This sub-group may delineate the most abundant clasts in Almahata Sitta but with only 11 fragments analyzed of some 300 recovered stones a representative sampling has probably not been acquired as yet.

The group of Almahata Sitta samples defined by $-1.07 < \Delta^{17}\text{O} < -0.91$ resemble the type II clasts of Kita et al. [4] and the “Hughes cluster” of Downes et al [5] in that the groups share the same range of $\Delta^{17}\text{O}$ values. The significance of grouping by $\Delta^{17}\text{O}$ values in the case of ureilites is unknown because the members of the groups so defined differ in some aspects of mineral assemblage and mineral composition from Almahata Sitta.

Fragment #25 has the oxygen isotope composition of an “H5” ordinary chondrite (Fig. 1). It has been identified petrographically as an “H5” ordinary chondrite and is unrelated to the ureilite Almahata Sitta.

Work is in progress to investigate a possible correlation between the mg# of olivine and pyroxene and their $\Delta^{17}\text{O}$ values [2,4,5].

Conclusions: It is now demonstrated beyond doubt that a single asteroidal body, Asteroid 2008 TC₃, contained clasts representative in their oxygen isotope compositions of all known ureilite monomict and polymict ureilites. The fragments of Almahata Sitta scattered in a line across the Nubian Desert afford researchers the puzzle pieces needed to reconstruct the ureilite’s parent body. Might all of the ureilites in their manifold heterogeneity have originated on the same parent body? Yes, and the samples are in hand to prove it.

References: [1] Jenniskens, P. and 34 co-authors (2009) *Nature*, 458, 485-488. [2] Clayton R.N. and Mayeda, T. (1988) *GCA*, 52, 1313-1318. [3] Franchi, I.A. (2008) *Rev. Mineral. Geochem.*, 68, 345-397. [4] Kita, N.T. and 5 co-authors (2004) *GCA*, 68, 4213-4235. [5] Downes, H. and 3 co-authors (2008) *GCA*, 72, 4825-4844.

Figure 1: Oxygen isotope compositions of fragments of Almahata Sitta compared to ureilites [1], [2]. Note that AHS #25 is an H5 ordinary chondrite, unrelated to Almahata Sitta .

